LACHINE CANAL

Decontamination Project

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Issues

DECONTAMINATION OF LACHINE CANAL

The enhancement of the Lachine Canal, a special part of our cultural heritage and an important recreational site in the City of Montréal, presently represents a challenge for managers of the Canadian Parks Service, Québec Region.

This manmade waterway, built between 1821 and 1825, was originally designed to bypass the Lachine Rapids. This 13.4-kilometre-long canal links Lake St. Louis with the Port of Montréal, crossing the southwestern part of the Island of Montréal. Over the years, the canal's dimensions were periodically enlarged so as to be able to compete with the other seaways in eastern North America, and it now exhibits the following features: a 17.5-metre drop between Lake St. Louis and the Port of Montréal, five locks (all disused), width varying between 50 and 91 metres and depth of 4.3 metres. Closed to river traffic in 1959 following the opening of the St. Lawrence Seaway, the Lachine Canal became the property of the Canadian Parks Service in 1977.

Owing to the proximity of the Port of Montréal, its importance for commercial traffic and its hydraulic potential, the Lachine Canal attracted numerous industries, which set up along its banks. In fact, 252 firms were established along the canal between 1821 and 1988. Since public concern for the environment is a relatively recent phenomenon, several of these industries were behind the deterioration of the canal environment through their operations and waste. Since waste management was not regulated at that time, it was carried out in the simplest, least costly way possible. Solid waste was spread on a vacant part of the company's property, while liquid waste was discharged into a watercourse or simply onto the ground.

As a result of this thoughtless contamination from past industrial activities, the Canadian Parks Service in 1978 prohibited the use of the waters of the Lachine Canal for recreational purposes, and immediately initiated a series of studies to seek a solution to this contamination problem. Studies conducted in 1978 showed that the water of the Lachine Canal was contaminated, compromising the site's enhancement. The discharge of municipal sewers above the canal led to bacteriological deterioration of the water, while sediment containing pollutants on the bottom of the canal itself contaminated the water flowing over it. The project to clean up the Lachine Canal was officially launched within the framework of the St. Lawrence Action Plan.

CURRENT STATUS OF THE CANAL

Surveys conducted in the canal by André Marsan & Associés, revealed accumulated sediment close to one metre thick, and showed that, compared with the other waterways in the Montréal area, the sediment on the canal bottom was highly contaminated by mercury (0.1 to 2.6 µg/g) and lead (200 to 840 µg/g). Laboratory tests showed that mixing the sediment would trigger chemical reactions which would lead to a transfer into the canal waters of the heavy metals contained in the bottom sediment. The same tests also indicated that this transfer rate was low.

Surveys conducted between 1978 and 1983 showed that the quality of the water in the canal could also be described as poor in bacteriological terms; this situation has been attributed to the high pollutant load at the canal entrance from Lake St. Louis. Construction of a common collector at Dorval has almost completely eliminated the main source of bacteriological contamination, and recent studies have shown a substantial improvement in water quality in this regard.

None the less, the contaminated sediment from past industrial activity still remains at the canal entrance and on the canal bottom. In present conditions, this contaminated sediment poses little threat. But this would not be the case if the canal waters were stirred up by nautical activity. The sediment would then likely be placed back into suspension in the water, and this would lead to movement of contaminants in the canal and eventually into the St. Lawrence River.

The possible presence of contaminants in the soil along the Lachine Canal is also of concern to Canadian Parks Service managers; their existence was recently noted on a lot next to the canal. In order to find out the condition of all its properties along the Lachine Canal, a study was recently conducted. This study involved historical research into past industrial activities and identification of potential areas of contamination. A soil and groundwater plan was then developed from this historical research, and work will shortly be undertaken to identify the characteristics of the soil and groundwater.

CANADIAN PARKS SERVICE CONCERNS

Before allowing development of the canal, the Canadian Parks Service wishes to ensure that it poses no threat to health. To this end, it is essential to remove the contaminated sediment deposited on the canal bottom or to isolate it in such a way as to prevent the dispersal of contaminants. Despite numerous and varied environmental concerns, the Canadian Parks Service wishes to return to the public the use of the waters of the Lachine Canal. The safe disposal of conta-

minated sediment represents without doubt one of the major components in the pursuit of a solution to this problem. The selection of a technique for disposing of and, if necessary, handling the sediment must be based on a painstaking examination of the different possibilities, taking into account the specific features of the environment.

In light of the current status of the Lachine Canal, the likelihood of sediment being carried through the canal and contaminating the water of the St. Lawrence River is minimal; but this possibility must be considered in evaluating the different decontamination techniques. If the water in the canal were disturbed, if there were a substantial increase in the rate of flow, or if the canal structures were altered, the pollutants imprisoned in the sediment could be released into the water and thus reach the St. Lawrence River via the Old Port of Montréal.

One criterion for selecting the best treatment method should be to minimize the operations of handling and transporting the sediment to its treatment or storage site. These operations involve risks of accidents, leaks of pollutants, water, air and noise pollution, as well as having an impact on urban traffic, not to mention their unsightliness.

Since the territory of the Lachine Canal is not physically separate from the other adjoining properties, there is a risk of transport or migration of pollutants, either through the entry of contaminated sediment from the Lachine Basin, through surface runoff or through groundwater. The chosen sediment treatment method must allow for this risk, and special measures will have to be taken to prevent the canal from being contaminated once again after the decontamination work has been carried out.

Whichever option is retained for the work, it could entail inconvenience for nearby residents. The noise and traffic generated by the work will have to be kept to a minimum.

PROJECT CONSTRAINTS

The Lachine Canal's location in a highly urbanized setting and the nature of the problem therefore require that an impressive number of technical, environmental, economic, legal and social factors be taken into account in selecting the method of treatment for the contaminated sediment. The volume of material to be handled and treated, more than 225,000 cubic metres of contaminated sediment in the Lachine Canal alone, is without doubt one of the major constraints of the project. Aside from private property along the canal, highways, railway tracks, a bicycle path and parks on either side of the canal make access to the site to carry out the work problematic. In addition, the territory of the Lachine Canal is subject to numerous servitudes which the Canadian Parks Service has to respect:

. 10 firms which take their supply of water for industrial processes from the canal;

. 14 underground electric lines belonging to Hydro-Quebec crossing beneath the canal bottom;

. various structures under the canal:

-three natural gas pipes crossing the canal;
-three high-density telegraph cables crossing;
-telecommunications cables;
-several major sewage and water supply pipes;

. two City of Montréal water intakes for cleaning sediment from various collectors.

The recovery of contaminated sediment from the waters of the canal would entail the release of a relatively large amount of contaminant. As a result, it could prove beneficial to undertake recovery of the sediment when the canal is dry. On the other hand, temporarily draining the canal is difficult for two reasons: the presence of fill at several points in the locks, and the Canadian Parks Service's obligation toward several industries with respect to their water supply. In addition, certain sections of the canal walls present short and medium-term stability problems which could be exacerbated if the canal were drained for several months.

OPTIONS ENVISAGED

Selecting the method for removing and disposing of sediment is no easy matter. To date, four options have been closely examined.

On-site neutralization of the sediment would be a permanent solution, but this method is not yet available in Canada. Its implementation would require sediment extraction, transport and drying operations, in other words dredging and treating the sediment along the edge of the canal so as to destroy all the contaminants it contains.

Burying the sediment at an appropriate site outside the canal would involve removing the contaminated sediment from the bottom of the canal and the Lachine Basin by means of dredges and transporting them to an approved site. Such an operation would generate high turbidity in the canal, and sediment lost upriver would have to be re-excavated downstream. The use of hydraulic dredges could prove more advantageous from some points of view, but construction of a settling pond would be necessary in order to transport the dredged material.

On-site stabilization of the sediment on the canal bottom by covering it with a membrane and granular material would serve to anchor the contaminated sediment to the canal bottom permanently. This would remove any danger of the contaminants being brought back into suspension and solution. To cover the sediment, it would be necessary to use a membrane pervious to water and biodegrading gases with the capacity to imprison the sediment and organic matter. In order not to be moved or carried away by the current, the membrane is covered with material that also permits a liquid and gas exchange between the sediment retained under the membrane and the water above. All these materials must be inert and innocuous for the aquatic environment.

In 1985, this technique for stabilizing sediment was the subject of research in the Wellington Basin6. The results obtained showed that it was possible to confine and anchor quasi-liquid sediment to the bottom of a stretch of water by means of a gravel-covered geotextile membrane. There is, however, a risk of the contaminants migrating to the groundwater.

The encapsulation of all the contaminated sediment from the bottom of the canal in safety cells along the banks within the actual canal was proposed by André Marsan & Associés as a solution for decontaminating the Lachine Canal. This option involves encapsulating the sediment in storage dykes within the canal. Each encapsulation zone would be subdivided into several enclosures to allow for the gradual deposition of the sediment so as to return to the canal only water meeting quality criteria, thus enabling users to benefit from it. After the sediment was deposited, the enclosures would be covered with a semi-pervious membrane, a protective sand layer and clean fill. This solution could be considered temporary in the sense that, should economically viable techniques for neutralizing sediment be developed, easy access to the contaminated sediment would be available, as it would be stored safely and brought together in several locations.

FURTHER STUDIES REQUIRED

To bring this project to fruition, the Canadian Parks Service will conduct the studies and surveys necessary to leave the least possible room for the unexpected, in order to minimize the potential negative impact of the project. These studies primarily involve the more detailed assessment of the volume of sediment to be treated, as well as identifying the characteristics of the area around the canal in order to determine its level of contamination and gauge its impact on the quality of the water in the canal. Studies will also be carried out to check the nature and quality of the suspended solids transported by water from Lake St. Louis and of the effluent still being discharged into the canal. The aim is thus to ensure that they no longer

constitute actual or potential sources of contamination. Finally, the detailed verification of the condition and stability of the canal banks and water regulation works must be carried out. In addition, the research studies presently being conducted seem likely to open the way to new technologies which have not yet been assessed; further options for the removal and disposal of the sediment could therefore be added to those presently under consideration.

ENVIRONMENTAL ASSESSMENT

In light of the fact that potentially major environmental impacts are envisaged, this project has already been submitted to the Federal Environmental Assessment Review Office (FEARO) for public review by an environmental assessment panel.

As proponent of that part of the canal under its jurisdiction, the Canadian Parks Service must prove before this panel that it has conducted an in-depth study by which the acceptability of the project may be gauged. This study, for which the terms of reference are presented in the second section of this document, will therefore determine the nature, extent and scope of project impact on the environment and will put forward measures to mitigate them. To this end, an exhaustive critical review of the different technologically and economically possible options must be carried out in such a way as to highlight the consequences of each one from the environmental, historical, archaeological, sociological and economic points of view.

Following the selection of one of the options, a detailed environmental assessment will be carried out concurrently with the drafting of final plans and specifications. The necessary corrections will then be made to the preliminary plans and specifications, and the measures required to prevent or minimize foreseeable environmental impact will be defined. In addition, the nature and scope of potential residual impacts will be identified.

An environmental follow-up program will also be developed to ensure that the corrective measures are adequate and that project impacts remain within acceptable limits. Should this not be the case, additional measures will be proposed. In light of the previous assessment, it will be necessary to identify the parameters best indicating the condition of the environment and its degree of contamination. This monitoring should bear primarily on the aquatic component, more particularly on water quality.

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Terms of Reference

CANADIAN PARKS SERVICE

TERMS OF REFERENCE

ENVIRONMENTAL IMPACT STATEMENT

DECONTAMINATION OF THE LACHINE CANAL

July 1990

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1. INTRODUCTION

Under the present conditions, the contaminated sediment in the canal presents few risks as the canal is not used for any recreational purposes and navigation is not permitted. However, the situation would be very different were the canal waters to be agitated by any sort of activity, in which case, the deposits of sediment would risk being re-suspended in the water, thus releasing the contaminants into the canal waters and eventually into the St. Lawrence River. Therefore, it is necessary to safely dispose of the sediment in order to decontaminate this site so that it may be developed.

Researching a global solution to decontaminating the Lachine Canal is complex as numerous constraints exist in addition to the following points being taken into consideration :

- The contaminated sediment in the Lachine Basin presents the risk of recontaminating the canal;

- The territory involved in the Lachine Canal decontamination project falls under several jurisdictions :

  . the Canadian Parks Service for almost all the Lachine Canal and its banks and a part of the Lachine Basin;

  . the government of Québec for the rest of the Lachine Basin;

  . Public Works Canada for the downstream portion of the old canal (located in the Old Port). This territory is administered by the Société du Vieux-Port.

  . Private owners for the Lachine Canal embranchments as well as for land situated in the immediate canal area.

The Canadian Parks Service, as proponent, must undertake a detailed study of the decontamination project to be able to judge its acceptability, to determine the nature and extent of any adverse effects such a project may have on the environment in order to avoid or minimize them, and also to follow the evolution of the project during and after implementation of the work.

Since potentially major repercussions can be anticipated, this project was referred to the Federal Environmental Assessment Review Office (FEARO) for public review by an environmental assessment panel. This study, along with the technical design studies, will constitute the document to be submitted. With this in

mind, an environmental study will be done taking into account the results of the technical study in order to analyze and evaluate the technical components of each option. Conversely, these technical aspects must be adjusted according to the adverse effects anticipated and the mitigation measures proposed.

The mandate will also aim to determine the terms of the environmental monitoring to take place during and after implementation of the work.

2. GOAL AND OBJECTIVES OF THE ENVIRONMENTAL ASSESSMENT

The planned environmental study is two-fold :

- to examine and assess the various possibilities for cleaning up the Lachine Canal in order to choose the best solution, on an environmental plan, for each of the constituent parts (parts under the Canadian Parks Service and the Société du Vieux-Port), given the technical, economic and sociological restraints. The environmental implications specifically related to each of the technically and economically feasible options are being examined.

- to assess in detail the environmental implications of the techniques of the selected solution in order to identify the best conditions for implementing the project and to reduce the impact on the environment to a minimum.

In order to attain this goal, the following objectives are being sought :

1. Study the data available on the project in order to be able to adequately assess it.

2. Describe the territory and the current use of the area.

3. Identify, describe and assess the importance of external factors which may interfere with the project and compromise its more of less long-term results.

4. Determine the nature and extent of the adverse environmental implications of each of the feasible options in the short, medium and long term.

5. Study in detail the option selected.

6. Determine the parameters to ensure environmental monitoring during and after implementation of the work.

7. Demonstrate the pertinence and validity of the environmental assessment done.

In attaining the objectives of the study, research and analyses will be carried out according to the requirements of the environmental quality associated with

the eventual development of the Lachine Canal and, in particular, according to the requirements related to various recreational and educational activities.

3. AREA UNDER STUDY

The territory being studied consists of the Lachine Canal and the surrounding area between Lac Saint-Louis and the Old Port, the Lachine Basin, the canal itself and the surrounding area as well as the old part of the canal which the Société du Vieux-Port is planning to clean up.

In certain cases, it will be necessary to go beyond this reference framework in order to address the requirements of specific aspects of the study, such as the sociological context.

HAMPSTEAD
CÔTE-ST-LUC
LACHINE
VILLE-ST-PIERRE
MONTRÉAL
MONTRÉAL-OUEST
PARC LA SALLE
VICTORIA
SHERBROOKE
ST-JACQUES
NOTRE-DAME
Saint-Laurent
LACHINE CANAL
LASALLE
PARC LEFEVRE
CORDNER
BOUL. NEWMAN
PARC ANGRIGNON
PARC OUELLETTE
SHEVCHENKO
PONT MERCIER (R.138)
LAVERENDRYE
CANAL DE L'AQUEDUC
CHAMPLAIN

FIGURE 1

AREA UNDER STUDY

4. REQUIREMENTS

The requirements of the mandate consist more specifically of the following points :

4.1 CONSULTATION OF THE DATA AVAILABLE ON THE PROJECT

To properly assess the Lachine Canal decontamination project, all the documentation available on the subject must be researched and analyzed. Resource people should be consulted to complete and confirm the information if necessary.

Thus, the following steps will be considered, without necessarily restricting the list to these :

4.1.1 Study the existing data on the area concerned as a means to defining the characteristics of the area and the present situation regarding the contamination of the Lachine Canal and the Lachine Basin.

4.1.2 Treat the data so as to point out the parameters of the area which are not sufficiently documented.

4.1.3 Analyze the documentation for thhe purpose of examining the principal avenues which could theoretically be applied to the decontamination of the Lachine Canal and thus ensure that all the possibilities have been considered. To date, four options have been examined in particular. They are :

- Removal of sediment by dredging and neutralizing it on the site;
- Removal of sediment by dredging and burying it in an appropriate site away from the canal;
- Stabilization of the sediment at the bottom of the canal in situ and covering it with a membrane and granular material;
- Incapsulation of all the sediment in safety cells on the banks inside the canal itself.

4.2 DESCRIPTION OF THE AREA AND PRESENT USE

To properly evaluate the environmental effects of any project or activity, it is indispensable to be familiar with the present resources. Thus, the existing documentation must be researched then supplemented with surveys and field research if necessary.

The following elements must be taken into consideration :

4.2.1 Geobiophysical constituents

The natural constituents of the environment of the area in question will be described, with emphasis on the elements of particular importance. A qualitative and quantitative description of the present use of the resources will also be given.

The information on this subject must cover the following elements :

4.2.1.1 Terrain

a) topography;
b) nature and composition of the soil bordering on the canal;
c) stability of the materials;
d) geological or relief particularities which are special, fragile, or particular.

4.2.1.2 Hydrodynamics and sedimentology

a) water levels, direction and velocity of currents;
b) water quality;
c) transportation of material and sedimentation conditions;
d) nature of the bottom (nature, chemical composition and toxicity of the sediment).

The existing data and that gathered in the technical study will be analyzed.

4.2.1.3 Flora

a) nature and general location of the vegetation;
b) relative abundance of the species;
c) its value as a habitat element;
d) particular importance regarding historical, social or esthetic aspects.

4.2.1.4 Wildlife

a) identification and location of aquatic wildlife habitats;
b) potential spawning grounds;
c) sports fishing activities.

4.2.1.5 Facilities

a) recreational facilities;
b) service facilities;
c) access routes and service corridors.

4.2.2 Historic and archeological constituents

a) industrial history of the canal;
b) historical elements such as the locks and the profile of the canal;
c) known and potential archeological sites along the canal.

4.2.3 Sociological constituents

a) social, economic and cultural context of the sector;
b) size, composition and lifestyles of the local population;
c) present use of the area in the sector under study;
d) general description of the present quality of life in the sector under study;
e) level of knowledge and information;
f) expectations of the population as concerns the canal;
g) attitude of the local population to the project;
h) public health protection.

4.2.4 Economic constituents

a) companies which depend on the Lachine Canal for their industrial processes;
b) municipalities which have rain sewer systems that drain into the canal.

4.3 IDENTIFICATION, DESCRIPTION AND EVALUATION OF THE IMPORTANCE OF EXTERNAL FACTORS WHICH MAY INTERFERE WITH THE PROJECT AND COMPROMISE THE RESULTS IN THE MORE OR LESS LONG TERM

As the Lachine Canal territory is not physically separate from the adjacent properties, the results of the decontamination works could be compromised by the introduction of new contaminants from whatever source. Therefore, the potential sources of new contaminants in the canal must be identified and evaluated. Without necessarily being restricted to the following list, these elements must be taken into consideration :

- **Quality of the water that feeds the canal**

The Lachine Canal is presently fed by the waters of the St. Lawrence River entering at Lac Saint-Louis. These waters carry pollutants.

- **Presence of contaminated sediment in the Lachine Basin**

Contaminated sediment is also found in the Lachine Basin at the entrance to the canal. This sediment can be re-suspended by turbulence in the water and water activities and be re-deposited in the canal.

- **Presence of contaminated sediment under the backfill near or under the canal**

One section of the canal, the Old Port, was formerly backfilled, and other backfill has been placed in different parts of the canal. Sediment could have been imprisoned under this backfill.

- **Presence of contaminated sediment in canal embranchments**

There are still a few basin embranchments to the Lachine Canal which may contain contaminated sediment.

- **Presence of contaminated soil along the canal**

The presence of contaminated soil near the canal has been identified in a few places both on Canadian Parks Service property and certain privately owned property adjacent to the canal.

- **Occasional discharge from overflows into the canal**

The Rockfield overflow presently discharges into the Lachine Canal.

- **Effluents flowing into the canal**

Ten or so companies discharge their waste water into the canal, however, it is supposed to be treated first. Several old sewer pipes have already been blocked off at the canal end, but some may not have been condemned yet.

- **Waste from rain sewers into the canal and run-off flowing towards the canal**

Run-off waters, be they canalized or not into rain sewers, may be laden with pollutants.

- **Any other factors**

Any other external factors which may recontaminate the Lachine Canal will have to be considered.

In order to evaluate the importance of these external factors of possible recontamination of the canal water, the environmental study consultant will have to analyze the information which will be gathered by the technical consultant as well as the existing information put together by organizations such as the Montréal Urban Community and the City of Montréal regarding these factors.

4.4 FOR EACH OF THE FEASIBLE OPTIONS (SEE SECTION 4.1.3), DETERMINATION OF THE NATURE AND EXTENT OF THE ADVERSE ENVIRONMENTAL IMPLICATIONS IN THE SHORT, MEDIUM AND LONG TERM

After detailing the characteristics of the area and its use, an exhaustive critical examination of the various technically and economically feasible options will be carried out in order to draw out the implications of each one from an environmental, historical, archeological, sociological and economic point of view. It will therefore have to identify, describe and compare the anticipated environmental implications of each of these options, emphasizing the activities likely to cause environmental disruptions. For each of these options, measures to avoid or mitigate the adverse effects or increase the positive effects will have to be dealt with:

- Consultation of all the pertinent documentation available concerning the preceding studies, including the technical and economic feasibility study done by the consultant responsible for preparing the plans and specifications.

- A critical analysis of the methods that could be applied to bring out the strengths and weaknesses from the point of view of reliability, environment, costs and efforts to be accorded to each option as well as any other criteria deemed useful. This analysis must make reference to the results of a technical feasibility study to be undertaken by the consultant responsible for preparing the plans and specifications.

- A critical evaluation of all the information missing from the detailed study of any option.

- A detailed examination of the nature of the different decontamination options by analyzing the various studies done and consulting the resource people concerned.

- For each of the options examined, judgement as to their acceptability from an environmental point of view.

- For each of the options considered feasible, identification and description of the geobiophysical, historical, archeological and sociological constituents in question.

- For each of the options considered feasible, determination of the nature and extent of the environmental implications directly related to the implementation of the project.

- Indication if it is possible to minimize or avoid these adverse environmental implications and, if yes, determination of the means to achieve this as well as the residual repercussions.

Each of the previously identified adverse implications of the project must be quantified according to the following assessment criteria :

- The intensity of the intervention : the area may be slightly or considerably altered.

- The value of the affected element with relation to a global vision of the area, or with relation to the present or future users.

- The duration of the intervention so as to indicate if the area or the quality of life may be affected temporarily or permanently.

In order to rank the various options according to their environmental impact, the consultant will have to prepare a detailed analytic grid which must take into consideration the previously mentioned elements in particular.

4.5 DETAILED EXAMINATION OF THE OPTION RETAINED

Following the decision by the Canadian Parks Service and the Société du Vieux-Port to retain one of the proposed options, a detailed environmental assessment of the option selected must be done during the preparation of the plans and specifications of each of the projects in order to :

- Specify if necessary any corrections to the draft plans and specifications.

- Identify the phases of the project which may have repercussions on the resources and the environment in general.

- Determine the nature and extent of the anticipated implications related to the implementation of the phases of the project. For example :

  . organization of the work sites;
  . transportation of contaminated sediment;
  . disposal of contaminated sediment;
  . the possibilities of contaminating adjacent sectors;
  . safety of the residents;
  . the means for providing the necessary corrective measures should unforeseen implications arise during implementation.

- Indicate the necessary measures to avoid or minimize the environmental implications identified. For the adverse implications on the elements identified in 4.4, short- and long-term mitigation measures must be drawn up in order to

eliminate potential repercussions or to minimize their effects so as to protect the resources in the territory being studied and the residents of the surrounding area. If any residual repercussions are anticipated, their nature and extent should be specified.

- Identify the nature and extent of the anticipated residual repercussions.

The plans and specifications for the Lachine Canal decontamination project must be checked at different stages of their preparation in order to judge the effect of the work and thus be able to recommend corrective measures immediately should unforeseen environmental implications arise.

A detailed environmental assessment must be done in particular during the preparation of the final plans and specifications in order to ensure :

- the integration of the mitigation measures previously established;

- that the developments and work requested do not involve any environmental implications not identified during previous studies;

- that provision be made for the necessary corrective measures should unforeseen repercussions arise during implementation;

- that the parameters assuring environmental monitoring during and after the work are adequate.

4.6 DETERMINATION OF THE PARAMETERS ENSURING ENVIRONMENTAL MONITORING DURING AND AFTER IMPLEMENTATION OF THE WORK

An environmental monitoring program will be necessary to ensure that the corrective measures are adequate and that the repercussions of the project remain within acceptable limits or, in the opposite case, to prescribe further corrective measures. Based on the prior assessment, the parameters most likely to indicate the state of the environment and more particularly its level of contamination must be identified. Water quality and the aquatic aspects should be the principal targets of this monitoring programme.

In order to monitor the environment, a practical methodology of gathering and analyzing the information required should be developed, taking into consideration the following points :

- a methodological approach for gathering data;
- characteristics of the instruments to be used;
- a method of analyzing and interpreting the results.

The period of time the environmental monitoring should be in effect will have to be specified.

The objectives of this environmental surveillance are to ensure that the mitigation measures produce the expected results and to detect any unforeseen environmental implications.

4.7 MAP

A map will be prepared to illustrate firstly the constituents of the area which have been identified and, secondly, the nature and extent of the expected implications.

4.8 CONTENT OF THE ENVIRONMENTAL ASSESSMENT REPORT

The final report will include :

4.8.1 A concise, precise summary of the contents of the environmental assessment. The summary must furnish a quick overview of the situation and subjects of interest must be easy to find. It must be easily understood by the general public and immediately ready for use by the media.

The summary should justify the options proposed, the inventory of resources, the foreseeable implications on the natural and social environment, the proposed mitigation measures, the residual repercussions (which cannot be mitigated) and their extent.

4.8.2 A statement describing the goal of the project and justifying its implementation.

4.8.3 A detailed description of the methodology used in carrying out the environmental assessment.

4.8.4 A description of the physical, biological and social contexts in which the Lachine Canal decontamination project will be implemented.

4.8.5 An analysis of all the data available, both theoretical as well as the results of the studies, thus enabling readers to compare the various options and rank them as to their environmental impact.

4.8.6 A description of the environmental implications of the option retained.

4.8.7 The publication of recommendations, if applicable, for minimizing the environmental implications of the work planned within the framework of the Lachine Canal decontamination project.

4.8.8 Details of the environmental monitoring program.

4.8.9 A conclusion of the report pointing out the principal results of the environmental assessment.

4.8.10 A bibliography of all the sources of reference consulted during the environmental assessment.

4.8.11 Illustration of the report with the aid of all visual documents which could clarify the contents.

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Technical Appendix

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1. CHARACTERISTICS OF THE AREA

1.1 Hydraulic characteristics of the canal

This 13.4km canal has an average width of 53 m and an average depth of 4.6 m. From the western extremity of the canal entrance in Lac Saint-Louis to the eastern end in the port of Montreal, there is a 17.5 metre difference in water levels.

The original canal was built to form four basins whose water level and flow were controlled by five locks. However, the original construction was modified. The principal characteristics of the canal in its present state are summarized in the table below. Subsequently, the various structures of the canal will be dealt with.

SUMMARY OF THE PRINCIPAL CHARACTERISTICS OF THE LACHINE CANAL

Approximate total length	13.4 km
Maximum width	76.2 m
Average width	53.4 m
Minimum width	45.7 m
Maximum depth	5.5 m
Average depth	4.6 m
Minimum depth	2.7 m
Normal water level:	
. exit, port of Montreal	5.1 m
. Basin no. 1	10.7 m
. Basin no. 2	14.8 m
. Basin no. 3	17.5 m
. Basin no. 4	20.3 m
. Entrance (Lac Saint-Louis)	22.6 m
Average flow	13.7 m^3/sec

1.1.1 Components of the canal

In its present state, the canal still has several water pollution monitoring installations which are described here briefly from downstream to upstream.

A) Installations at Site no. 1

At present, basin no. 1 no longer exists because the canal was filled in between locks nos. 1 and 2 for building construction. The water flows through an underground main between basin no. 2 and the port.

B) Installations at Site no. 2 (Mill Street)

At site no. 2, from north to south, there is an adjustable weir, six adjustable sluice gates and an adjustable weir. The largest water level changes of the present canal (maximum 6.1 metres) take place at these installations. The retained water forms the shortest basin of about 1 220 metres.

C) Installations at Site no. 3 (Des Seigneurs)

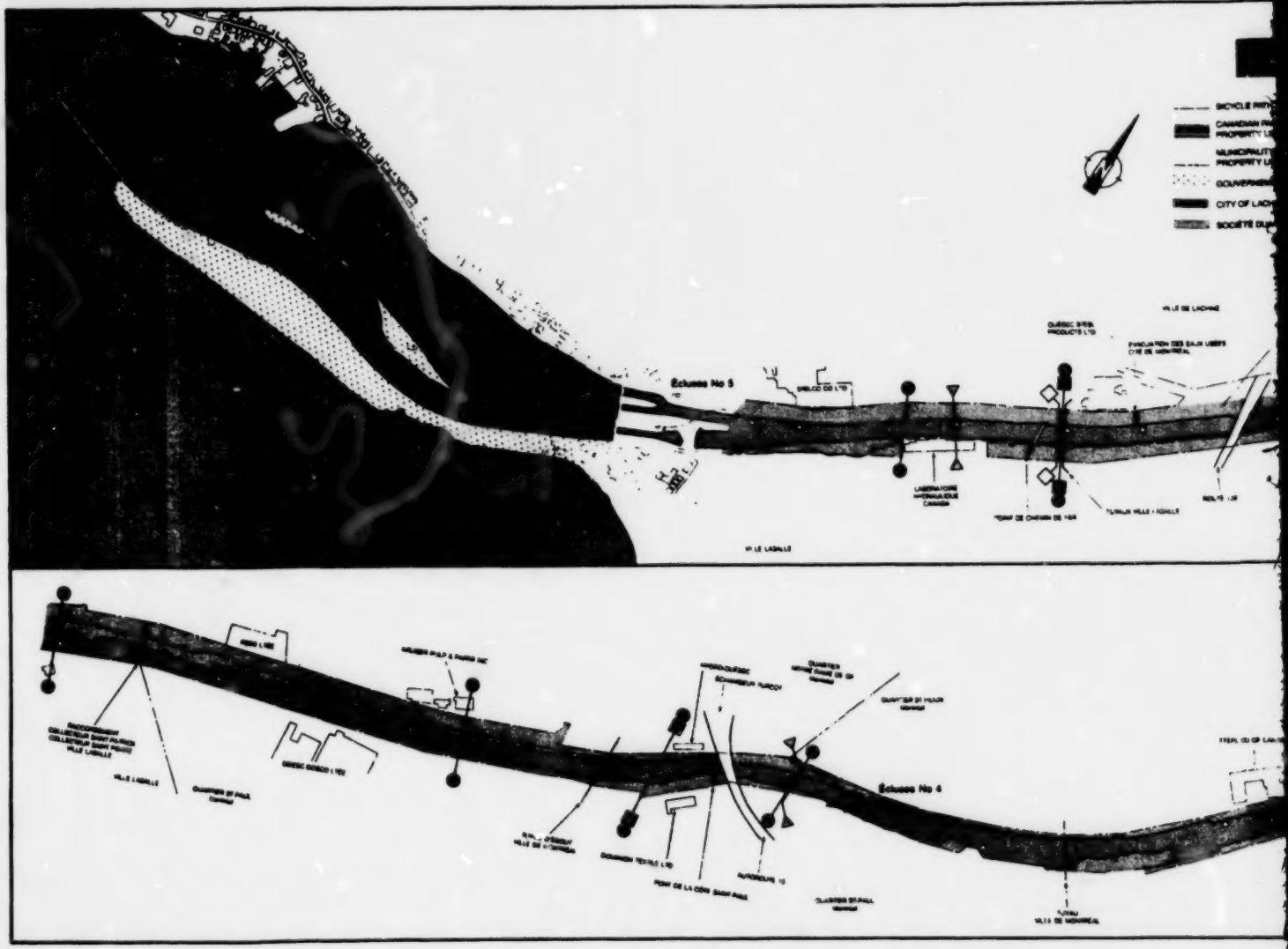
These installations, divided by a central platform, include an adjustable weir and four adjustable sluice gates on the south side and a wide overflow weir on the north. The average water level change here is 2.7 metres. Basin no. 3 which is formed by the raised water level is about 3 049 metres long.

D) Installations at Site no. 4 (Côte St-Paul)

Here a central platform divides the channel in two. On the south side are four adjustable sluice gates and a weir which can be adjusted with planks. On the north side there is an overflow weir. An average of 3.1 metres separates the levels of basins 3 and 4, the latter being the longest basin (7 012 m) of the canal system.

E) Installations at Site no. 5

A dike was placed across the north part of the channel at site no. 5. Part of the water flows presently through a wide diameter pipe. The average difference in water level between Lac Saint-Louis and basin no. 4 is 2.1 metres.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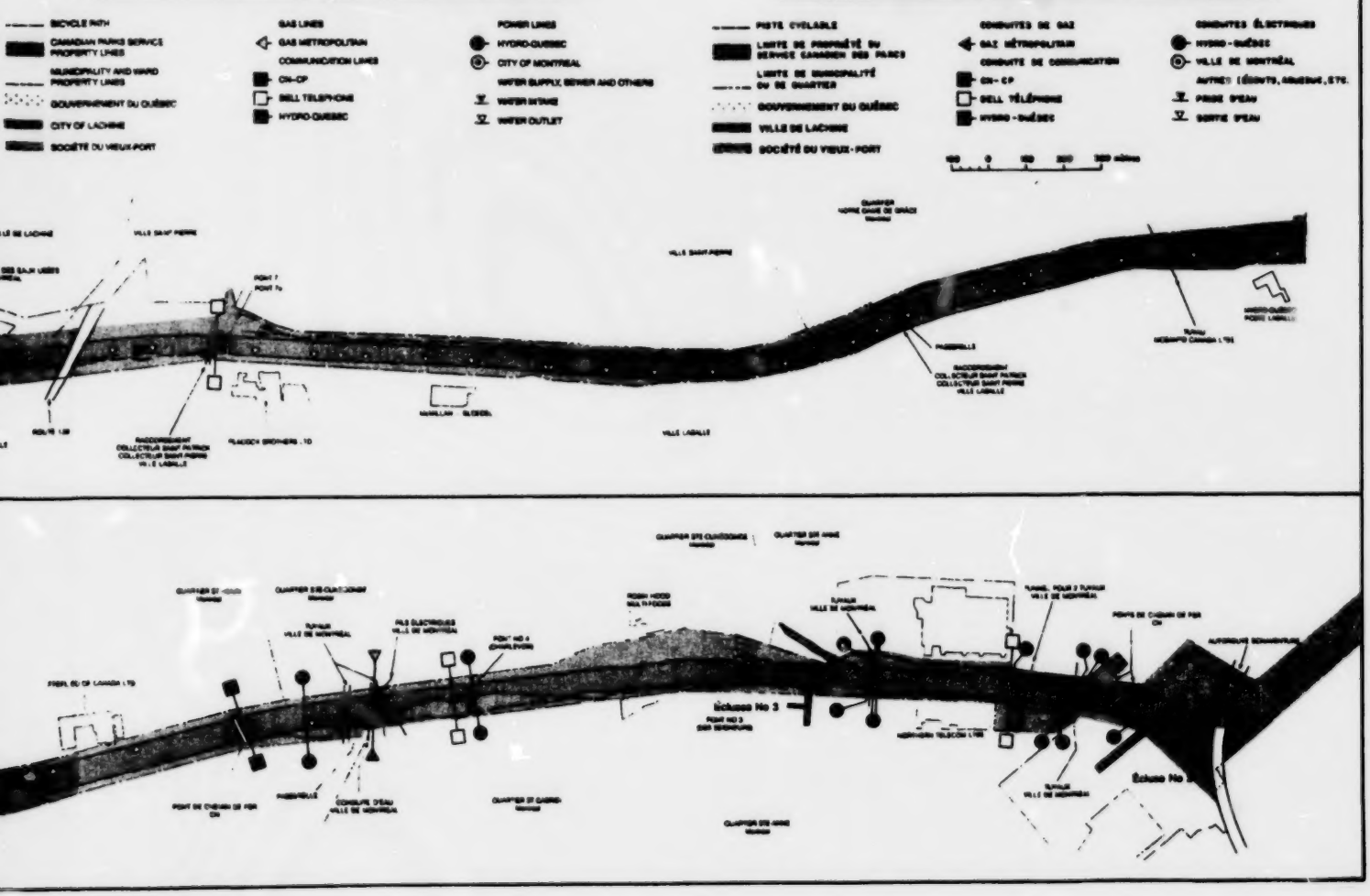
Lachine Canal

Canal de Lachine



1.1.2 Present state of the canal

The 1978 measurements taken by the firm Marsan et Associés consulting firm at 12 different places along the canal indicate that its depth is fairly constant, with the following exceptions:

- upstream not far from the installations at site no. 2, an accumulation of 3.7 metres of loose material near the north bank of the canal has been noted;
- upstream near the installations of site no. 3, there is a deposit some 1.8 metres thick on the southern half of the channel;
- along the south bank of the canal downstream of the installations at site no. 4, a maximum difference in water levels of 1.7 metres indicates the presence of sediment deposits.

For lack of recent technical information on the walls of the Lachine Canal, the exact condition and stability of the banks cannot be given. The canal was partially drained for about ten days in the summer of 1986 in order to study the condition of the banks, the nature of the bottom and the debris present, and to calculate the volume of sediment that had accumulated over the years. The resulting calculations and observations indicated that the banks were relatively stable in general and could withstand emptying. However, there would probably be problems of stability in certain places, such as the wooden sections of the walls (cribwork) which could rupture locally during a prolonged empty period. Moreover, the presence of various backfills in some spots along the canal could contribute to local sliding if the canal were drained quickly. This problem could be serious if the backfill contains a large percentage of fine unreinforced clay.

1.1.3 Water levels, flow and velocity of discharge

The water level at the entrance of the Lachine Canal are controlled by the water level of Lac Saint-Louis whose maximum fluctuations are around 3.1 metres while the average level is 20.7 metres.

In general, the velocity of discharge profiles follow the shape of theoretical curves, in other words, the maximum velocities are found near the surface (5 to 13.4 cm/sec) and the minimal velocities near the bottom (3 to 7 cm/sec at a depth of 2.00 m). Transversally, the velocity is in general quite uniform.

The average velocity of discharge of the water measured is very low and very constant, on an average 0.06 ± 0.01 m/sec. The corresponding flow is 13.7 m^3/sec. However, opening the sluice gates of the locks causes certain hydraulic changes, particularly increasing the velocities and reducing the depth of water. The folloving table indicates the different flows depending on the position of the sluice gates and water levels.

FLOW AND VELOCITY CALCULATED ACCORDING TO THE POSITIONS OF THE SLUICE GATES AND WATER LEVELS LACHINE CANAL

FLOW	SLUICE GATES CLOSED		SLUICE GATES OPEN	
(m^3/sec)	WATER LEVEL (m)	AVERAGE VELOCITY (m/sec)	WATER LEVEL (m)	AVERAGE VELOCITY (m/sec)
13.7	20.1	0.06	18.6	0.10
30.0	20.5	0.12	19.2	0.17
60.0	21.1	0.24	20.5	0.26
90.0	*	0.29	*	0.31

According to the the measurements taken by the firm Marsan et Associés in 1978, the canal's capacity with its present equipment cannot safely contain a flow much over 60.0 m^3/sec without risking overfloving.

1.1.4 Suspended and deposited sediments

According to the measurements taken by the firm Marsan et Associés in 1978, the concentration of suspended sediment is relatively low, between 7 and 14 mg/l all along the canal. This low rate does not exclude a certain amount of sediment from being deposited in the canal. Nevertheless, under the present conditions, depositing is relatively low.

1.2 Quality and quantity of sediment and their effects on water quality

1.2.1 Quality and quantity of sediment

The total volume of sediment laden with organic matter at the bottom of the Lachine Canal and Basin has been evaluated at 445 000 m^3: 230 000 m^3 in the canal and 215 000 m^3 in the basin. The surveys revealed there was about a one-metre thickness of accumulated sediment, the quality of which is presented in the table that follows.

Compared to other water courses in the Montreal region, the canal sediment is highly contaminated with mercury (0.1 to 2.6 µg/g) and lead (200 to 840 µg/g). There are no precise standards on acceptable levels of contaminants in sediment. For information purposes only, we can refer to the sediment quality assessment criteria established by Vigneault et al. (1978) which the ministries of Environment Canada and Environnement Québec use in evaluating dredging projects and determining whether sediment can be disposed of in open water. As shown in the table that follovs, the maximum concentration of metals in the sediment exceed the maximum values indicated.

The nutrient and coliform content was also high in 1978. The concentration of chlorine derivatives chlorobenzenes and mirex in the sediment was low. No mirex was found in the samples taken at a detection limit of 0.2 p.p.b.

The elutriation tests chemical analyses done by Marsan et Associés shoved that stirring up this sediment would cause chemical reactions which would transfer heavy metals from a solid to a liquid phase.

QUALITY OF SEDIMENT ON THE BOTTOM OF THE LACHINE CANAL 1978

	REFERENCE CRITERIA *		CONCENTRATIONS MEASURED		
	Acceptable	Unacceptable	Maximum	Average	Minimum
HEAVY METALS: (µg/gram of dry sediment)					
Mercury (Hg)	0.3	1.0	2.63	0.90	0.09
Lead(Pb)	20	60	840.00	470.00	200.00
Cadmium (Cd)	5	8	12.00	5.00	< 2.00
NUTRIENTS (mg/gram)					
Phosphates	0.7	1.0	0.92	0.47	0.17
Nitrates			0.061	0.021	0.006
COLIFORMS (coliforms / gram)					
Coliforms			803 565	49 343	422
CHLORINE DERIVATIVES (mg/kg of dry sediment)					
Total PCBs			1.90	0.77	0.11
Chlorobenzenes			< 0.1	< 0.1	< 0.1

* Acceptable and unacceptable concentrations for disposing of sediment in open water (Vigneault et al., 1978). These criteria take into account present knowledge of the effects of different degress of contamination and data obtained on the quality of sediment in the St. Lawrence. However, they are not bases on the assessment of actual repercussions on the environment, and therefore, do not constitute immutable values.

1.2.2 Effects of the sediment on water quality

In general, the existence of natural sedimentation underlies the process of eliminating pollutants present in a column of water above them. These pollutants simply accumulate in the sediment in concentrations much higher than in the water. However, there is an exchange between the liquid and solid phase wherein a balance is obtained. This equilibrium can be modified by several factors such as pH, the degree of agitation, the graduations of sediment and the chemical nature of the pollutants.

Re-suspending heavy metals causes chemical reactions, amongst others, which can increase the pollutant content in the aqueous phase. In addition, the solubility and mobility of the metals increase as the acidity of the solution goes up. Lab experiments have shown a low transfer rate of the heavy metals contained in the canal sediment and tend to indicate that the surface exchanges may remain low. However, the exchanges can become greater when the sediment is stirred up such as during dredging operations. Because of the high levels of heavy metals in the canal sediment, especially mercury and lead, any amount becoming soluble again could result in high levels in the water.

The transfer of nutrients (phosphates and nitrates) from the solid to the liquid phase are considerable especially when the pH becomes more and more acidic. The intensity of these transfers is also very variable given the range of processes that could be produced. However, they present a lesser potential danger than the heavy metals.

1.3 Water quality

1.3.1 Results obtained from water analyses and quality sought

The canal's water quality must be examined with regards to two separate aspects: physico-chemical characteristics and the toxic products it transports.

The results of physico-chemical analyses carried out by various organizations in 1980, 1981, 1982 and 1983 highlight the following conclusions:

- at a given point in the canal, the concentration of pollution indicators such as the biological oxygen demand (DOB_5), oil and grease, suspended material and coliforms varies appreciably from month to month and from year to year;
- at a given time, the concentration of these same indicators varies from one point to another in the canal.

The essential points of these results are presented below along with the water quality sought in order to safely allow recreational activities. The

reference levels for the principal parameters established by McNeely, Neimanis et Dwyer (1980) are presented according to the values obtained in the canal in 1983. The limiting factors of this water are also indicated.

- **Dissolved oxygen:** levels of 7 and 9 p.p.m. of dissolved oxygen were reported; the lower limit not to be exceeded is 4 p.p.m. In the canal, this factor does not create a problem because the locks and subsequent stirring up of the water make it saturated in oxygen.

- **PH:** varying between 6.5 and 8.0, the pH does not constitute a limiting factor. The pH should be between 6.5 and 9 for aquatic environment protection and recreational usage.

- **BOD_5:** this parameter represents a measurement of pollution for which no principle has been suggested. McNeely et al. (1980) deem a level of 4 p.p.m. or less reasonably clean water. The canal water averages around this level, therefore, this parameter should not endanger the aquatic environment or recreational activities.

- **Oil and grease:** normally, concentrations below 5 p.p.m. do not cause problems. The measured levels of 0 and 7 p.p.m. are indicative of human activity but present no danger for fish or leisure activities including swimming.

- **Nutrients:** the levels of nutrients (NO_3 - PO_4) are high, that is, between 1 and 4 p.p.m. Because of water circulation in the canal, neither algae nor eutrophication should develop.

- **Heavy metals:** the following chart indicates the heavy metal content analysed:

	Measured values
chrome	0.15 p.p.m
copper	0.05 to 0.19 p.p.m.
lead	0.10 p.p.m.
mercury	0.002 p.p.m.
zinc	0.08 to 0.16 p.p.m.

These concentrations do not hinder survival of fish, however, they may present certain limiting factors in the propagation of the species, particularly in the case of zinc and copper.

- **Pathogenic bacteria:** the total number of bacteria seems to vary little with the place of the sampling; the measurements taken in 1983 were all of the same order, that is, 150 000 bacteria per 100 ml. The limit is 500 bacteria per 100 ml for recreational use.

RECAPITULATION TABLE OF WATER QUALITY CRITERIA

PARAMETERS	DOMESTIC CONSUMPTION	AQUATIC LIFE PROTECTION	RECREATIONAL USES
dissolved oxygen		>4.0 p.p.m.	
pH	>6.5 and <8.5	>6.5 and <9.0	>6.0 and <9.0
BOD_5		<4 p.p.m.	
oil and grease	n.d.		= <5 p.p.m.
nutrients			
- nitrates and nitrites	<10.0 p.p.m.		
- total phosphates	<0.1 p.p.m.	<0.025 p.p.m.	
heavy metals			
- chrome	<0.05 p.p.m.	<0.04 p.p.m.	<0.1 p.p.m.
- copper	<1.0 p.p.m.	<0.005 p.p.m.	
- lead	<0.05 p.p.m.	<0.03 p.p.m.	
- mercury	<0.001 p.p.m.	<0.0001 p.p.m.	<0.001 p.p.m.
- zinc	<5.0 p.p.m.	<0.03 p.p.m.	
pathogens			
- coliform bacteria			
. fecal			<100/dL
. total	<10/dL		<500/dL

Source: McNeely, Neimanis et Dwyer (1980)

1.3.2 Water quality coefficients of change

Variations in the water quality of the canal are a function of several coefficient. The main ones are:

- the water quality of Lac Saint-Louis at the canal entrance;
- the quantity and quality of substances discharged into the canal;
- marina activities upstream of lock no. 5;
- the flow of the canal;
- the self-purifying capacity of the canal.

The water quality of Lac Saint-Louis is the main factor determining the quality of the water in the Lachine Canal because it is almost entirely fed by the lake. The water quality of Lac Saint-Louis is influenced in turn by several factors. The main ones include:

- the water quality of rivers flowing into the lake;
- agricultural and urban activities along the shores of the lake;
- the topography of the lake.

1.3.3 Sources of contamination of the Lachine Canal

The water quality of the canal was poor from a bacteriological point of view according to studies done between 1978 and 1983 because of the high level of pollution entering the canal from Lac Saint-Louis.

Because of the combined effects of the three factors mentioned above, and particularly because of the high bottom along the north shore of Lac Saint-Louis, the quality of water entering the canal was largely influenced by that of the Ottava River and the sevage system of Dorval. Dilution of these sewers only took place past the Lachine Rapids hence the poor quality of water entering the canal. The very weak flow and velocity of the water explain the existence of residual pollutants all along. The canal right from the entrance as well as the lov self-purifying capacity of the canal.

Wastes dumped into the canal since it opening also represented a considerable factor as companies along both sides of the canal, municipal drainage systems and the Rockfield overflow contributed mainly to the discharges.

1.3.4 Corrective measures taken and improvements observed

To improve the water quality of the canal from a bacteriological stand point at the canal entrance, the following solutions were proposed by Marsan et Associés (1984):

- feed the canal through a water intake in the middle of the rapids where the quality is better;
- feed the canal through a water intake far from the north shore;
- stop the dumping of sevage from the city of Dorval;
- set up a disinfection system to lower the number of viable bacteria in the canal waters;
- regulate marina activities at the entrance of the canal in order to control the sanitary effluent and discharges of oil and grease.

In addition to these solutions, sanitary sewage discharge into the canal had to be eliminated and run-off water discharges reduced in order to maintain an acceptable level of bacteriological quality.

The progressive link up of partial sewage pipes and the construction of a main sewer in Dorval have almost completely eliminated the sources of bacteriological contamination and thus greatly improved the water quality. These corrective measures have enabled the canal to be fed water of a very acceptable quality comparable to the water in the middle of Lac Saint-Louis. The situation has clearly improved since 1978.

The construction of the Saint-Patrick sewage system reduced and continues to eliminate discharges into the Lachine Canal. Almost no domestic sewers will discharge into the canal any more. The principal discharges being dumped into the canal now come from the waste water of various industrial processes from a few companies. However, this source of pollutants is relatively low.

2. RESTRICTIONS IN IMPLEMENTING THE PROJECT

The size of the problem and the location of the Lachine Canal in the middle of a heavily urbanized area restrict the decontamination project on several technical, economic, environmental and legal planes.

The prevailing element of the project is the volume of sediment to be handled and treated. Some 445 000 cubic metres of contaminated matter are lying on the bottom of the canal and the Lachine Basin.

Because of its historical role as an important link in the system of Canadian navigable waterways, the Lachine Canal constitutes a valuable heritage resource to be safeguarded. Some of the options being considered involve the partial loss of certain historical aspects of the canal.

Roads, railway tracks, a bicycle path and parks along the canal as well as private property on the edge of the canal in certain places make access to the site for clean-up purposes somewhat complicated. In addition, the canal territory includes several rights of way which the Canadian Parks Service must respect:

- ten companies use canal water in their industrial processes;
- 14 underground Hydro-Québec electrical lines lie at the bottom of the canal;
- there are three natural gas lines under the canal;
- three high density telegraph cables are buried under the canal;

- there are telecommunications cables under the canal;

- several large sever and aqueduct pipes are buried under the canal;

- there are two water supply points belonging to the city of Montreal for cleaning the sediment from various sewers.

Recuperating the contaminated sediment directly from the canal waters would cause a fair number of contaminants to be released. Therefore, it might be preferable to recuperate the sediment in a dry phase. However, temporarily draining the canal is difficult because of the backfill in several places in the locks and the Canadian Parks Service's obligation to various companies for their water supply. In addition, certain sections of the canal walls present stability problems in the short and medium term, and these could worsen should the canal be drained for several months.

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APPENDIX

GLOSSARY, SYMBOLS AND ABBREVIATIONS

A) GLOSSARY

Aerobic:	indicates the presence of gaseous or dissolved oxygen.
Biological oxygen demand (BOD_5):	reduction in the amount of oxygen in a water sample kept in a dark place at a certain temperature over a given period which is caused by the bacterial decomposition of organic matter. The biological oxygen demand is measured after five days.
Contaminant:	any solid, liquid or gaseous matter, micro-organism, sound, heat, smell or combination thereof which changes the quality of the environment in some way.
Criteria (water quality):	scientific data assessed to determine the recommended scientific limits of water use.
Downstream:	lower part of a water course (in the direction of the current) in relation to a given point.
Effluent:	complex wastes (ex: industrial liquid wastes or waste water) which may be released into the environment.
Eutrophation:	process of increasing nutrients in natural waters, usually indicated by an increase in growth and reproduction (increase in the biomass).
Ground water:	subsurface water often situated under a layer of impermeable land (particularly clay).
Heavy metals:	metal elements with a high atomic weight (ex: copper, lead, etc.) whose density is over 5.

Nutrients:	environmental substances (elementary or compound) necessary for the growth and development of plants and animals.
pH:	selected values representing the acidity or alkalinity of an aqueous solution; defined as the logarithm of the inverse of the concentration of hydrogen ions.
Potable water:	water that is drinkable and usable for culinary purposes; drinking water.
Restriction, limitation, constraint:	an environmental, economic or technical factor which harms or hampers the implementation of a project.
Run-off water:	precipitation water which flows directly or indirectly to a body of water as run-off.
Sediment:	deposit of suspended or dissolved matter in a liquid.
Standard (water quality):	objective set out in the executory laws on environmental protection, promulgated by a level of government.
Turbidity:	cloudiness caused by sediment suspended in water.
Upstream:	part of a water course between a given point and its source.

B) SYMBOLS AND ABBREVIATIONS

µ	micro- = 0.000 001
mg	milligram
g	gram
l	litre
p.p.m.	parts per million
p.p.b.	part per billion